Pavement Management Plan

Prepared for:

Village of Lake Zurich
Lake County, Illinois
January 26, 2015

Manhard CONSULTING

Executive Summary

The Village of Lake Zurich has expressed interest in developing a plan to maintain its roadway network. Manhard Consulting was retained to prepare this Pavement Management Plan (PMP) to assist the Village in pavement management decision making. This report summarizes the findings of detailed field inspections, and provides a budget analysis and proposed five-year capital plan.

PAVER™ 7.0 software was chosen as the preferred database and analytical tool. Field inspections were completed in the summer of 2014. PAVER™ uses this data collected during the field inspections to assign each street a rating, on a scale of 0 to 100, known as the Pavement Condition Index (PCI). The PCI ratings provide a snapshot of the Village's overall street condition (see *Table A).*

Table A – PCI Category Breakdown by % Area

Pavement Condition Category (0-100 PCI)	Excellent (100-86)	Good (85-71)	Satisfactory (70-56)	Poor (55-41)	Very Poor (40-26)	Serious (25-11)	Failed (10-0)
PCI Category by % Area	24.55%	29.09%	28.31%	14.33%	3.22%	0.18%	0.33%

The Village of Lake Zurich currently owns and maintains 79.8 miles of asphalt roadways. Streets are classified under four categories: residential (70%), collector (13%), arterial (9%), and industrial (8%). **The current area-weighted average PCI of the Village is 73 (good)**, with approximately 54% of streets by area rated as "good" or above.

PAVER™ analyzes the current PCI ratings against historical project data to develop Deterioration Curves that can be used to forecast future pavement condition. Four funding scenarios were prepared using this feature to determine the resulting Village PCI after 10 years (see *Table B).*

Table B – Funding Scenario Results

Plan	Beginning PCI	Ending PCI	Deterioration Rate (Per Year)
1. **Do Nothing**	73	44	±(2.9)
2. Current Pavement Budget (FY14-15) $1.5 million – Major Repairs $20k – Preventative Maintenance	73	62	±(1.1)
3. Maintain Existing PCI $2 million – Major Repairs $200k – Preventative Maintenance	73	73	±0
4. Backlog Elimination over 10 Years $2.7 million – Major Repairs $300k – Preventative Maintenance	73	80	±0.7

Lake Zurich currently has a low percentage of streets in "very poor" to "failed" condition and an acceptable overall PCI rating. Manhard Consulting recommends that Lake Zurich strive to maintain the existing PCI rating (Funding Scenario 3). Based on the funding recommendation under that budget scenario, a five-year plan was created using the PAVER™ analysis, project location considerations, and Village staff input. The five-year plan is summarized in *Table C*. Each annual project listed in the five-year plan should be inspected the year before construction to provide a final determination on work type and cost.

Table C - 5-Year Road Program Plan

Year	Location	Work Type	Approximate Cost
2015	Lake Zurich Manor Subdivision, Ancient Oaks Subdivision	Pulverization Mill & Overlay Reconstruction	$2,000,000
2016	The Orchards Subdivision, Mossley Hill Estates	Reconstruction Mill & Overlay	$2,100,000
2017	Sparrow Ridge, Various	Mill & Overlay	$1,900,000
2018	Old Rand Rd, Main St, Grand Ave	Mill & Overlay	$2,100,000
2019	Bristol Trail Subdivision	Mill & Overlay	$1,900,000

The Village should continue preventative maintenance measures utilizing the recommended $200,000 per year budget. Locations of preventative maintenance will vary by year, with a recommended crack seal project approximately three to five years after a street is resurfaced, reconstructed, or constructed. Sufficient funding directed toward preventative maintenance can add 10 years to a street's life, which amounts to significant savings long term.

The PMP is a living document that should be evaluated on a regular basis. Village-wide pavement condition assessments should be performed in conjunction with the preparation of subsequent five-year capital plans to ensure that the PMP is meeting the goals of the Village.

Contents

List of Figures

List of Appendices

I. Introduction

The Village of Lake Zurich understands the value and importance of properly maintaining its roadway network. The Board of Trustees authorized the preparation of this report to assist the Village in pavement management decision making. Manhard Consulting, Ltd. was retained to perform a comprehensive study of Lake Zurich's roadways. The resulting Pavement Management Plan (PMP) summarizes the findings of detailed field inspections, and provides recommendations for annual maintenance and capital improvement project funding for 2015 through 2019.

The main goals of the PMP are to answer the following questions:

1. How many lane miles of roadway does the Village maintain?
2. What is the current condition of the Village's pavements?
3. How fast are the roads deteriorating?
4. What prevention, maintenance, and rehabilitation strategies can be used?
5. How can the pavement life be extended?
6. How much funding is necessary to meet Village goals?

The Village of Lake Zurich owns and maintains 79.8 miles of asphalt roadways. Over the last 30 years, the Village has added over 41 miles of roadway, with approximately 7.5 miles added within the last 15 years. As more streets are added to the Village's network, the Village must anticipate the need for increased maintenance funding obligations.

Further, at reconstruction costs approaching $1 million per mile, it is important that the Village develop and implement a plan to effectively manage its roadway assets. The PMP aims to protect the investment already made in the network by establishing maintenance standards and prioritizing maintenance treatments.

II. Pavement Management Theory

Why Manage Pavement?

Years ago, asphalt pavements were expected to last 25 years with little maintenance. Today, it is becoming more and more apparent that these pavements in many cases barely last half that time. Experts point to various reasons. The product "asphalt" is vastly different from what was produced years ago. Oil refineries are now able to refine crude oil to a much greater extent, extracting more fuels, perfumes and other products, resulting in an asphalt product of lesser quality. Also, traffic has increased substantially. From 1970 to 1990, the growth of vehicles outpaced the population growth by 50% and today there are 40% more registered vehicles than in 1980.

Highway engineers have studied the life cycle of pavements over the years and found that pavements deteriorate over time at a fairly predictable rate. *Figure 1* presents a typical Pavement Deterioration Curve and illustrates how the pavement condition changes over time. In the first three-quarters of a pavement's life, the rate of deterioration is fairly slow. However, the next 17% of its life, the deterioration accelerates rapidly.

Figure 1 - Pavement Deterioration Curve

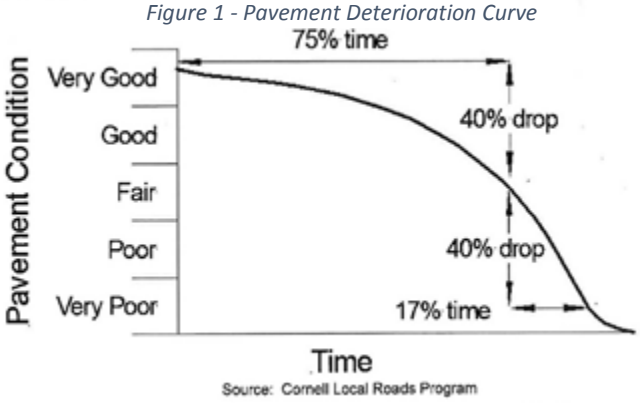
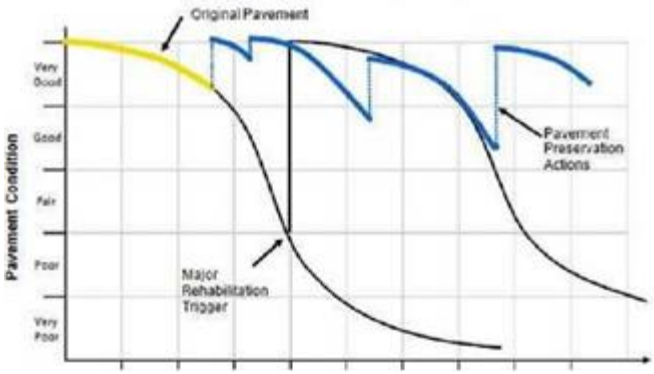


Figure 2 shows how repeated Preventative Maintenance will extend the life of a pavement. **Preventative Maintenance applied when the pavement is in good condition will keep the pavement in good condition, delay the point in time when the rapid deterioration will occur, and extend the life of the pavement.** These repairs include crack sealing and other surface treatments which are relatively inexpensive. As the pavement further deteriorates, more extensive (and expensive) repairs become necessary. When a pavement reaches the Very Poor stage, the pavement is usually structurally deficient and needs to be reconstructed. The cost of reconstruction is significantly greater than the cost of the minor repairs.

Figure 2 - Pavement Preservation Actions

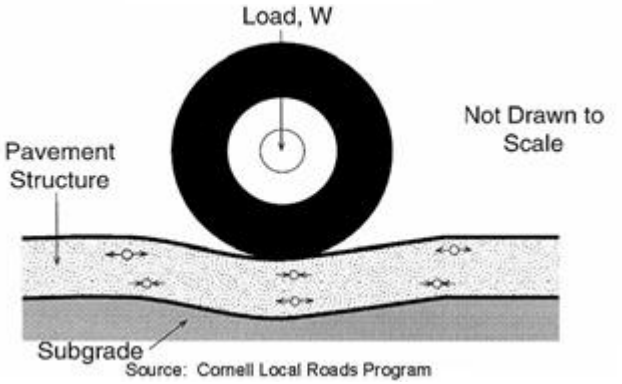


This concept illustrates the underlying principle of a Pavement Management Plan - that it is cheaper to keep roads in good shape than it is to fix roads that are broken. The "keeping good roads good" philosophy is similar to what we practice in our own lives. We change our car's oil regularly rather than waiting for the engine to fail and replacing it. We periodically paint the siding or repair damaged roof shingles on our homes rather than waiting to replace the entire siding or roof structure.

Why Do Pavements Fail?

In a perfect world, pavement would last forever, but unfortunately, this is not the case. To understand why a pavement fails, we need to understand what a road is. Asphalt pavements are called "flexible pavements" as they resist traffic loads by deflection (flexing or bending). Asphalt pavements are constructed as a system of layers that work together to bend when traffic loads are placed on them *Figure 3*. The bottom layer is the "Subgrade" or the earth below the pavement materials. The "Pavement Structure" is typically a layer of aggregate base material covered by layers of hot mix asphalt. As the pavement flexes, there is a combination of pushing and pulling stress in the pavement. The thicker the Pavement Structure, the less deflection and stress in the Subgrade. When a pavement is subjected to repeated wheel loads and subsequent structural deflection, the pavement becomes fatigued, resulting in cracking.

Figure 3 - Pavement Deflection



Pavements fail for a number of reasons and often these factors combine to compound the issue.

Water is probably the greatest contributor to pavement failure. The strength of the base and Subgrade is substantially reduced when saturated. These materials become overly flexible and in turn cause excessive stress in the Pavement Structure. Further, a saturated pavement is susceptible to frost heave from repeated freeze thaw cycles. As the water freezes, ice pushes up on the pavement causing additional stresses that accelerate cracking. When the ice thaws the gap left by the ice weakens the pavement structure. Repeated freeze thaw cycles also break the bond between the asphalt materials and the aggregate within the bituminous mix. Each step in the freeze thaw cycle has a detrimental effect on the Pavement Structure.

Pavements may fail due to poor quality construction. Improper compaction of the Subgrade and the asphalt materials may leave excessive voids in the materials. Excessive voids allow water to enter the materials where freeze thaw cycles and compression forces of vehicle loads contribute to fatigue of the pavement. It is also important to compact asphalt materials at the correct temperatures as cooled asphalt cannot be compacted adequately.

A Wisconsin Asphalt Association study identifies a current subdivision construction practice may contribute to subdivision pavement failures. Residential roads are generally designed for residential traffic and the occasional heavy vehicle such as buses and garbage trucks. During the construction process, the roadway construction is staged so as not to build the final layer of the asphalt until a majority of the homes have been completed. The intent is to protect the finished surface from cosmetic damage. However, this practice exposes the limited pavement structure to repeated use by heavy construction traffic not originally accounted for in the pavement design and potentially causing the pavement to fail prematurely.

Pavement Distresses

Individual pavement failures are often called distresses and common asphalt pavement distresses can be categorized as Cracking, Surface Deformations, and Disintegration.

Cracking

Cracks caused in asphalt pavements can take many forms. Cracks usually start as very thin cracks that widen and erode with age. If cracks are not addressed in a timely fashion, they can ravel and develop into multiple cracks requiring more extensive repairs. The most common types of cracks found in streets include Fatigue, Longitudinal, Traverse, and Edge cracking.

Fatigue Cracking is a series of interconnected cracks forming many sided pieces resembling the skin of an alligator (fatigue cracking is also known as Alligator Cracking) and is caused by the inability of the pavement structure to sustain the repetitive traffic loading (fatigue). Alligator cracking is usually associated with either drainage problems of the base materials or insufficient thickness of the pavement structure for the traffic utilizing the pavement. Alligator cracking only occurs in areas subjected to repeated loading. For arterial roads (State or County Roads) this tends to be the wheel paths, however residential traffic tends to use all parts of the pavement and alligator cracking can occur almost anywhere in the pavement. Small areas may be fixed with a patch or area repair. Larger areas require reclamation or reconstruction as the distress derives from base problems. Drainage must be carefully examined in all cases.

Longitudinal Cracks are long cracks that run parallel to the center line of the roadway. These may be caused by failure of the paving construction joint down the center of the road, by frost heave or by base failure due to traffic loading. Left untreated, multiple parallel cracks will form and the width of the cracks will expand, allowing water to enter and infiltrate the base material. When subjected to repeated traffic loading, alligator cracking forms. Longitudinal cracks should be filled or sealed when the cracks are narrow. Multiple cracks or alligatoring may require patching.

Transverse Cracks form at right angles to the centerline and are created by contraction of the pavement due to cold temperatures. The cracks initially occur at long consistent spacing intervals, approximately 50 to 100 feet apart. As the pavement ages, its exposure to the elements causes it to harden and become brittle (sometimes termed "Oxidation"), no longer allowing the pavement to expand and contract with changes in temperature. Over time, the crack spacing interval becomes smaller and at about 10 feet spacing, the cracking is termed "Block Cracking." Left untreated, the width of the cracks will expand, allowing water to enter and infiltrate the base material. When subjected to repeated traffic loading, alligator cracking forms. Transverse and Block Cracks should be filled or sealed when the cracks are narrow and not too deteriorated. Multiple cracks or alligatoring may require patching. Periodic surface treatment will slow the age hardening of the asphalt binder and retard development of thermal cracks.

Edge Cracking is parallel to the edge of pavement / curb and gutter and is generally within a few feet of the pavement edge. Edge cracking usually results from the lack of support due to weakened base material from excessive moisture. Similar to other cracks, untreated cracks will widen, allow infiltration of water to the base materials and when subjected to repeated traffic loading, alligator cracking will form. At low severity, the cracks may be filled. However, as the severity increases, patches and replacement of the distressed areas may be required. In all cases, excess moisture should be eliminated.

Surface Deformations

Pavement deformation is the result of weakness in one or more layers of the pavement. Typical deformation distresses in residential pavements include Rutting, Shoving and Swell.

Rutting is characterized by a surface depression parallel to the centerline, usually in the wheel paths or along parking lanes. In many instances, ruts become noticeable only after a rainfall when the wheel paths fill with waters. Rutting is caused by a permanent deformation in one of the pavement layers or subgrade, resulting from the consolation or displacement of the materials under traffic loads. Minor surface rutting can be filled with paver placed surface treatments. Deeper ruts caused by base failures may require patches or reconstruction.

Shoving is a longitudinal displacement of an area of the pavement surface caused by traffic loading. When traffic pushes against the pavement, it produces a short abrupt wave in the pavement surface. Shoving is normally attributed to asphalt mixtures with too much asphalt cement or fine aggregates. Minor shoving areas can be repaired by patching; larger areas may require milling and resurfacing.

A swell is characterized by an upward bulge in the pavement surface, a long gradual wave more than 10 feet long and can be accompanied by surface cracking. Swells are an expansion of the supporting layers beneath surface course and are typically caused by excessive moisture and frost heaving. Swells are repaired by excavating the inferior subgrade and reconstruction the section of the road.

Disintegration

The progressive breaking up of the pavement into small, loose pieces is called Disintegration and can be related to problems with the supporting layers or with the surface. Typical Disintegration distresses include potholes, patching and weathering.

Potholes are localized holes or voids that form in the pavement structure. Potholes start as fragments of the asphalt surface dislodge, and over time continue downward into the lower layers of the pavement. Potholes are formed when the pavement disintegrates under traffic loading due to water related issues in one or more layers of the pavement. Pothole often appears after rain or during thaw periods when pavements are weaker. Potholes should be patched by removing the deteriorate asphalt pavement and replacing with new materials. Area repairs or reconstruction may be required for extensive potholes along with an investigation of potential drainage issues.

Patches are portions of the pavement that has been replaced with a new material to repair the existing pavement or to cover a utility trench. The edges of patches inherently introduce cracks to the pavement. If these cracks expand, water will enter the patch and degrade the pavement base, causing the patch to fail again. Additionally, if the patch did not correct a base or subgrade problem that originally existed, the problem will continue and the area and will eventually fail. Patches over utility trenches often settle when the base material is not compacted adequately and settlement occurs. A deteriorating patch needs to be expanded and repaired.

Weathering or raveling of the pavement surface occurs when there is a loss of asphalt content in the surface mix. Asphalt is a sticky, black and highly viscous liquid that acts as the binding agent to "lock" aggregates together in pavements. The asphalt content is lost or weakened over time through exposure to extreme temperatures and sun radiation. Without asphalt, aggregate dislodges from the pavement structure. Raveling can be accelerated by traffic and freezing weather. Surface treatments such as asphalt rejuvenator can be applied in the early stages of pavement life to retard weathering and raveling impacts. Small localized areas may require surface patching and if left untreated, large areas may require milling and overlay of new asphalt surface.

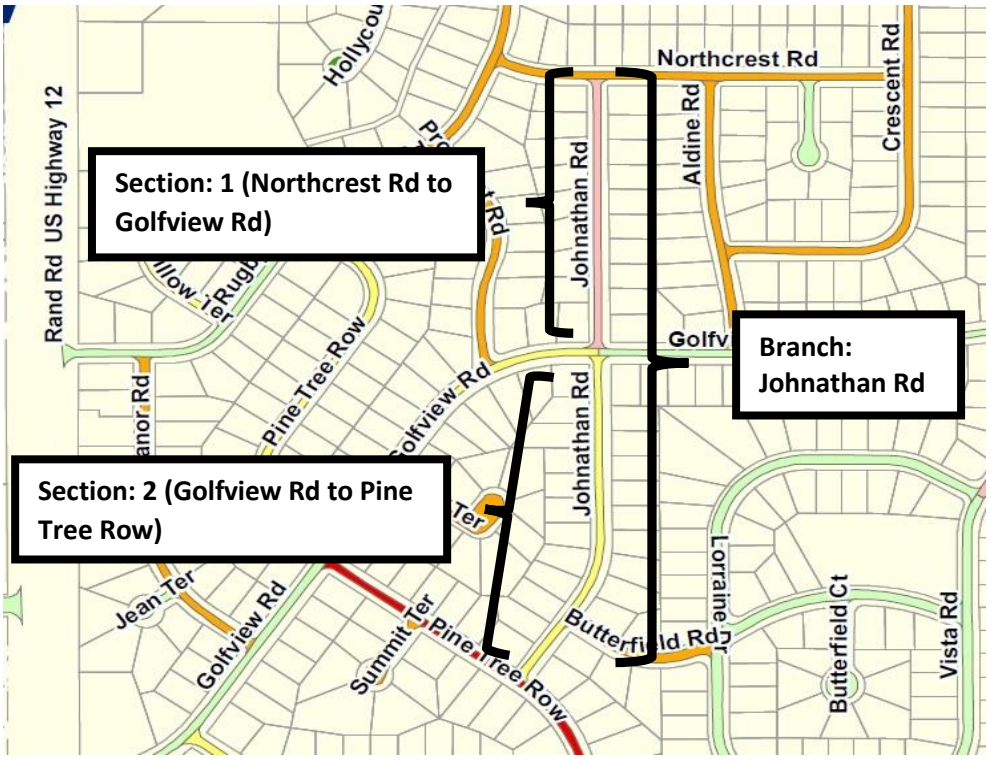
III. Approach

Manhard Consulting used the PAVER™ 7.0 software program to log inspection reports, analyze data, and prepare preliminary cost estimates for the PMP. PAVER™ utilizes the **Pavement Condition Index (PCI) rating system** to establish a snapshot of the existing pavement conditions. The PCI rating methodology was developed by the US Army Corps of Engineers and the University of Illinois. It is the only pavement rating system to have received an American Society of Testing Materials (ASTM) standard designation (D6433) and is the only pavement rating system recognized for rating road and parking lot pavements. The PCI method works on a numerical system from 0 (Failed) to 100 (Excellent). Within the PCI range of 56-100, a street is considered to be in satisfactory to excellent condition, while a PCI of 0-55 is considered to be in failed to poor condition.

Network Identification

The first step in the process is to create the roadway network in PAVER™. Manhard Consulting used a combination of existing data from Lake Zurich's GIS and Lake County's GIS to create the underlying roadway information (i.e. street name, length, width). In PAVER™, streets are further broken down into branches and sections. See *Figure 4* below.

Figure 4 - PAVER Branch & Section



Pavement Condition Assessment

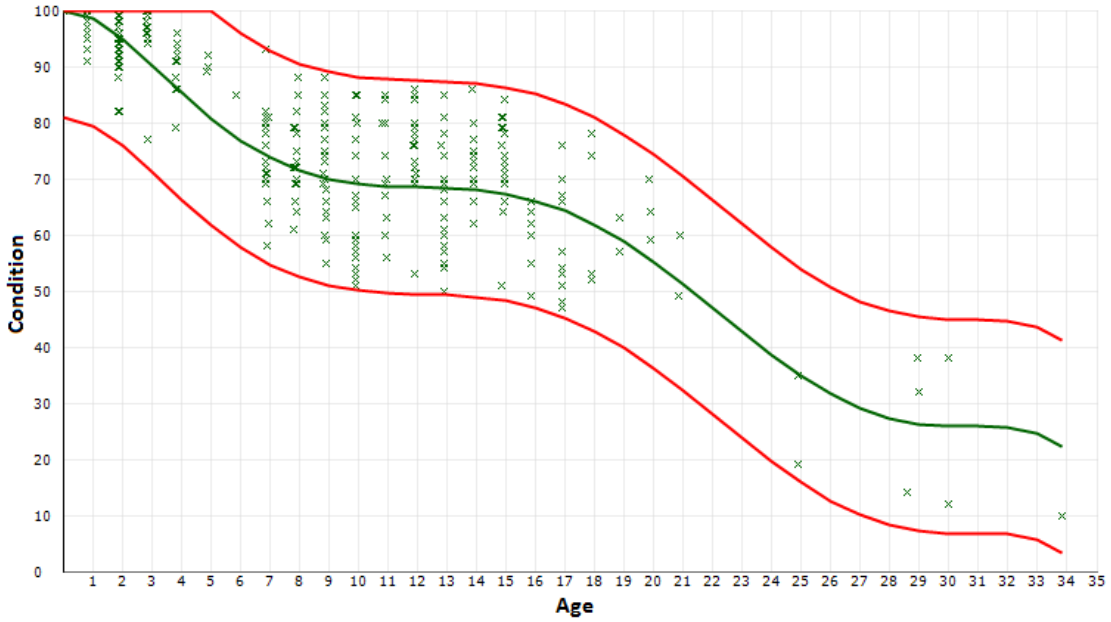
The next step is to determine the PCI of each Village owned street. A two-person field crew inspected representative samples of each street for twenty (20) different distress classifications, including alligator cracking, longitudinal cracking, potholes, patching, etc. The number of sample inspections for a given street was determined by the total area of the street. For example, Old Rand Road had 25 inspection locations, whereas Jean Terrace had only one inspection location. Sample locations were chosen by the field crew to be representative of the street as a whole. The most common distresses observed in the Village were longitudinal/transverse, alligator, and edge cracking, explained in detail under Section II.

After the sample data is collected, it is input into PAVER™ to attain the PCI ratings. The PCI ratings at this point provide a snapshot of current pavement condition.

Deterioration Curves

To predict future pavement condition, PAVER™ has a tool called a "PCI Family Model." A PCI Family Model is a prediction modeling tool that uses actual historical data input by the user to determine a rate of deterioration. Manhard Consulting acquired historical data including last known construction and/or major repair dates from Lake Zurich project archives and GIS imagery. PAVER™ uses the historical data in conjunction with the current PCI of each street to graph the anticipated deterioration of Village streets over time, as shown in *Figure 5.*

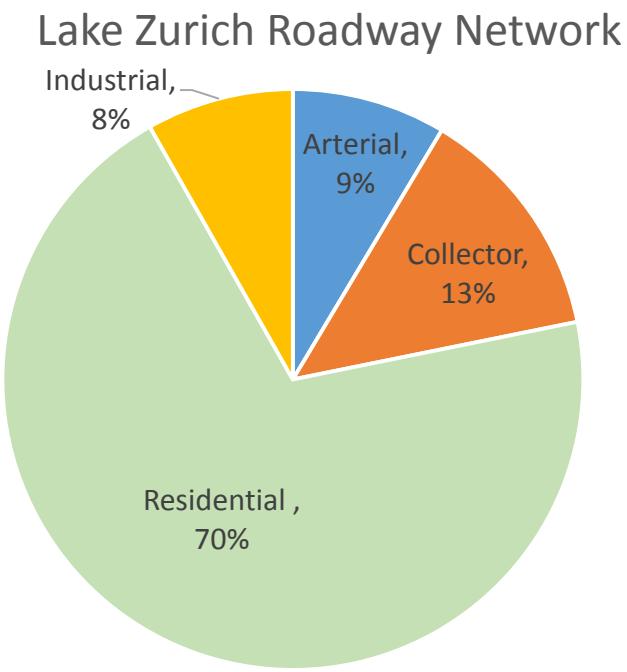
Figure 5 - Deterioration Curve – Residential Streets



The green trend line shown in *Figure 5* is the average deterioration rate of Village residential streets. Since the rate of deterioration is greatly dependent on the traffic loading and pavement

cross-section, PAVER™ creates a separate deterioration curve for each classification (or "family") of street - industrial, residential, collector, and arterial. The breakdown of classifications as a percentage of total street area is shown in *Figure 6*.

Figure 6 - Lake Zurich Street Rank Breakdown



Maintenance and Repair Strategies

Once the deterioration rate of each Village street has been predicted, Maintenance and Repair (M&R) plans can be produced. To do this, "M&R families" must also be created, in a similar fashion to PCI Family Models. PAVER™ assigns costs to repair a street based on the PCI rating. For instance, a street with a PCI of 60 will cost less to repair than a street with a PCI of 30. But there are other factors: Does the street have curb and gutter, sidewalk, or thicker pavement? For that reason, M&R families are created that assign customized repair costs depending on the presence of one or more of the abovementioned factors.

The remainder of this section details recommended maintenance and rehabilitation strategies based on their PCI categories. Recommendations are intended to be used as a planning tool and not to give definitive street-by-street repair data. Detailed project scoping and field verification is necessary before proceeding to construction.

Category – Excellent (PCI 86-100), little to no maintenance required

If a pavement section is categorized as "excellent", it will have been recently resurfaced or constructed. In most cases no maintenance is required, however the Village may choose to be proactive by crack sealing along the curb line and center seam to prevent seepage into the base of the road.

Figure 7 - Ginger Tr (Excellent)

Category – Good (PCI 71-85), preventive maintenance required

Streets with a rating of "good" are usually 3-6 years old, and have experienced enough freeze thaw cycles to show signs of increased distress. While the distresses may still be relatively minor, they are prime candidates for preventative maintenance techniques. It is recommended that the Village use a combination of crack sealing, asphalt rejuvenator, and spot patching to restore deteriorating areas of the roads.

Figure 8 - Orchard Pond Dr (Good)

Category – Satisfactory/Poor (PCI 41-70), thin mill and overlay required

It is at this point in the pavement's lifecycle that there will be distresses ranging from low to high severity. Maintenance tactics such as crack sealing and asphalt rejuvenation likely will not be effective, as the structural integrity of these streets has typically been compromised. Streets in the satisfactory and poor categories are recommended to be rehabilitated utilizing several strategies including area spot repair of failed base, pavement patching, resurfacing or overlay of existing asphalt pavement.

Figure 9 - Foxmoor Ln (Satisfactory)

Figure 10 - Aldine Rd (Poor)

Category – Very Poor/Serious/Failed (PCI 0-40) full depth removal and reconstruction required
When the PCI rating is 40 or below, the street will be showing high severity distresses at multiple locations. Rehabilitation for these streets can become very costly, so every effort should be made to keep streets from entering into these categories. Typically, streets of this category will need to have extensive rehabilitation performed or will require reconstruction. The extensive rehabilitation methodologies could include base repair with full-depth pavement patching, pulverization of existing asphalt pavement with placement of new asphalt pavement, or resurfacing of the full asphalt pavement thickness. If the street has deteriorated to the point where the structural integrity has completely diminished, reconstruction is the recommended course of action. Reconstruction involves removing the pavement at full depth, through the surface layers of asphalt and into the stone base, and constructing the street to its original state. **While resurfacing costs on average $4.00/sq. ft., reconstruction can cost upwards of $8.00/sq. ft.** In extreme circumstances, reconstruction is necessary, however rehabilitation techniques can be implemented in the earlier stages of the pavement deterioration process which can remedy structural failures without the need for an expensive reconstruction.

Figure 11 - Edelweiss Dr (Very Poor/Serious/Failed)

IV. Existing Conditions

The PAVER™ analysis yielded Pavement Condition Index (PCI) ratings for every street in the Village, providing a snapshot of current pavement conditions. Each section of roadway has its own PCI value, which is computed using algorithms based on the type and severity of measured distresses. PCI ratings are separated into seven (7) categories. The Village's distribution per category is shown in *Figure 12*.

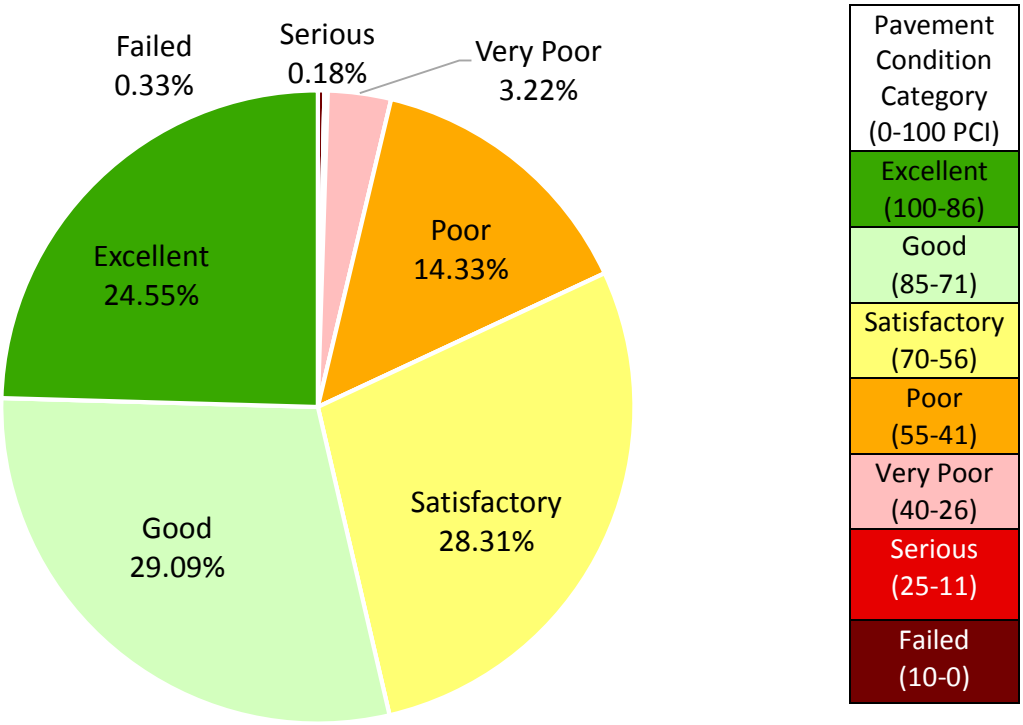


Figure 12 - PCI by Area Breakdown

The Village of Lake Zurich currently has an area-weighted average PCI of 73. Based on the categorization of PCI ratings, the Village has a score in the low range of "good". Moreover, approximately 54% of Village streets by area are in the category of "good" or above.

Appendix 1 includes a graphical representation of the PCI ratings added to the Lake Zurich GIS base map.

V. Budget Analysis

Lake Zurich has a major investment in its roadway network. A main goal of the PMP is to determine how much funding is necessary to maintain the Village's streets over the long term. Manhard Consulting evaluated four (4) funding scenarios and the associated impacts on the overall PCI rating of the Village.

Scenario 1: Do Nothing (Rate of Deterioration)

The "do nothing" scenario is a good starting point when comparing various funding alternatives because it shows the rate of deterioration that the Village must overcome through its maintenance and rehabilitation programs. **Given no funding over the next 10 years, the Village pavement condition would deteriorate at a rate of approximately 2 PCI points per year**, going from a PCI of 73 in 2014, to 54 in 2023. The Village must provide funding which will offset this natural deterioration rate.

Scenario 2: Current Pavement Budget (FY14-15)

In 2014, the Village budget included $1.5 million for road repairs, and $20,000 for crack sealing. Under this funding scenario the PCI is projected to drop from 73 to 62 between 2014 and 2023, respectively. This scenario confirms that the current program budget is insufficient to counteract the rate of deterioration over time.

Scenario 3: Maintain Existing PCI

Lake Zurich's current PCI rating of 73 is in the "good" range of the pavement categories. A potential goal is to maintain the existing PCI over the long term. After running various iterations of preventative to major repair funding ratios, it was determined that the allocation of $200,000 to preventative maintenance and $2.0M to road repairs would allow the Village to maintain its existing PCI rating. Access to increased preventative maintenance funding will result in extended useable life of streets, and ultimately decreased cost to the Village.

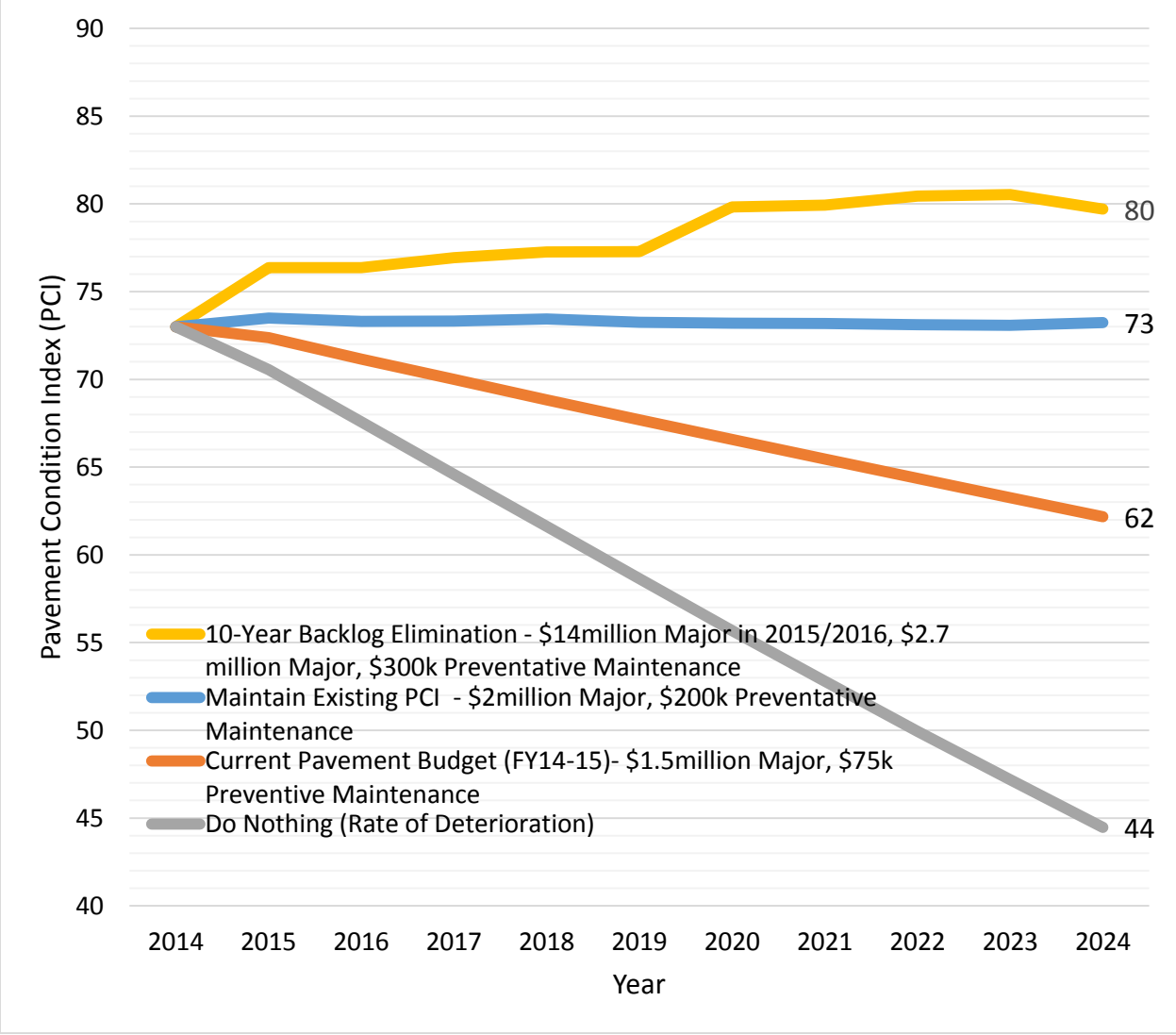
Scenario 4: Backlog Elimination

If funding permits, another potential goal is to have no streets below the rating of "satisfactory". To restore all streets in the "failed" thru "poor" categories, a plan was formulated to eliminate this backlog over 10 years. The plan would cost the Village an estimated $2.7 million in major repairs, and $300,000 for preventative maintenance. This backlog elimination plan represents an aggressive plan to raise the standards of the Village's streets. Over a ten year period, the Village's PCI would increase to 80.

Funding Scenario Results

The four (4) funding scenarios were entered into PAVER to forecast PCI ratings over 10 years. *Figure 13* shows a graphical comparison of the funding scenarios and the associated change in the PCI rating over 10 years.

Figure 13 - Budget Scenarios



Note: Construction price inflation was not taken into account as part of this analysis. The Village should consider making the appropriate inflation adjustments during the annual budgeting process.

VI. Five-Year Capital Plan

The proposed Five-Year Capital Plan was created using the "Maintain Existing PCI" funding scenario. The funding parameters were added to PAVER™ to determine the highest priority street sections over the given time period. The output was refined based on limitations of the software, site inspections, project location planning, drainage issues, and Village staff input. A summary of each project is presented below. The overall map is shown as *Appendix 2*.

2015 Road Program: Lake Zurich Manor and Ancient Oaks

The 2015 Road Program will consist of the streets highlighted in **orange** in *Figure 14.* The average time since last major work for streets in the proposed 2015 road program is 19 years, and the average area-weighted PCI rating for the area is 48 (Poor).

The Lake Zurich Manor has a "rural" cross-section consisting of drainage ditches and culverts rather than curb and storm sewer. It is recommended that pavement core reports and area drainage be reviewed in detail to determine the final scope of repair work. For the purposes of this report, Manhard Consulting assumed street pulverization, which consists of recycling the existing asphalt and base material in place, then laying a new asphalt surface overtop. This method improves the structure of the road, but also raises the street profile 4-6 inches.

Ancient Oaks has an "urban" cross-section with curb and storm sewer. Pulverization is not an option since the profile of the road cannot be raised. Sebby Lane has a PCI of 12 and is priced for reconstruction. The remaining cul-de-sacs will likely require a mill and resurface treatment.

Figure 14 - 2015 Road Program

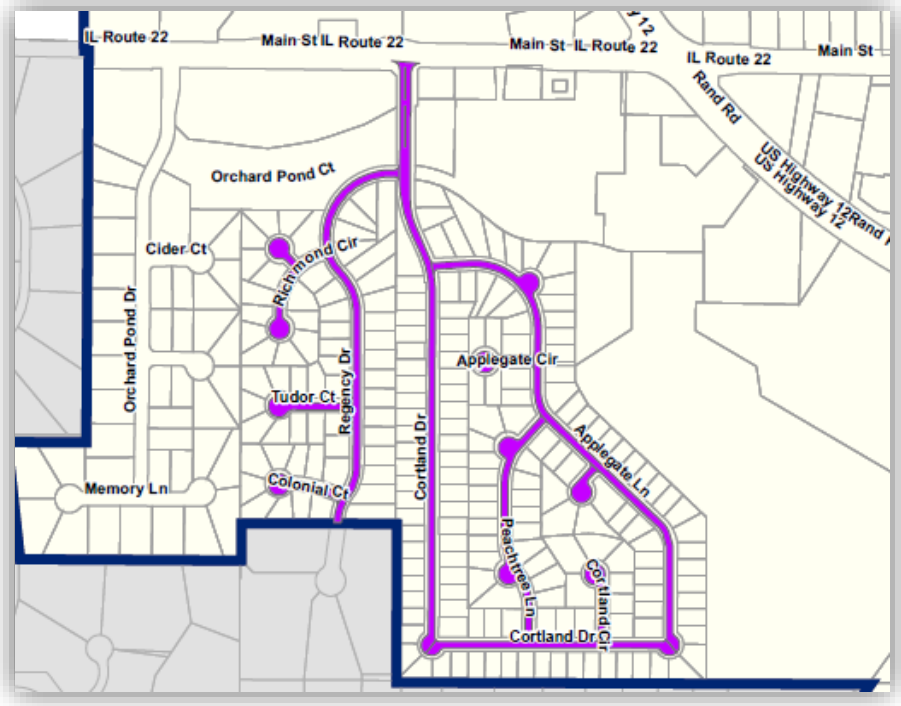
2016 Road Program: The Orchards and Mossley Hill Estates

The 2016 Road Program will consist of the streets highlighted in **purple** in *Figure 15.* The average time since last major work for streets in The Orchards will be 18 years, and 11 years for Mossley Hill Estates, by the year 2016. The average PCI rating in The Orchards is 58 (satisfactory), and 53 (poor) in Mossley Hill Estates.

The Orchards and Mossley Hill Estates both consist of an "urban" cross section, with curb, storm sewer, and sidewalk. Initial surface analysis of The Orchards showed signs of minor base failure, however upon a follow-up site inspection it was determined that the pavement had settled 1" to 2" along the curbline in portions of the subdivision. Settlement of long stretches of pavement is indicative of major base failure. The Orchards may require more extensive patching or full depth milling due to the presence of edge failures. Mossley Hill Estates will benefit most from a regular resurfacing and patching, as base failure is not widespread. The Orchards will be surveyed in 2015 to make a final determination on what rehabilitation techniques will be utilized. Depending on the extent of base issues, the scope of this year's project may be reduced to fit the Village budget.

The cost to perform a full reconstruction in The Orchards could be as much as $8/sqft, almost double the $4.50/sqft for a regular resurfacing. Should The Orchards require reconstruction, and additional funding is not available, it is possible to delay the Mossley Hill Estates resurfacing by patching areas of base failure. Patching is only a temporary solution, but will extend the useful life of the street.

Figure 15 - 2016 Road Program

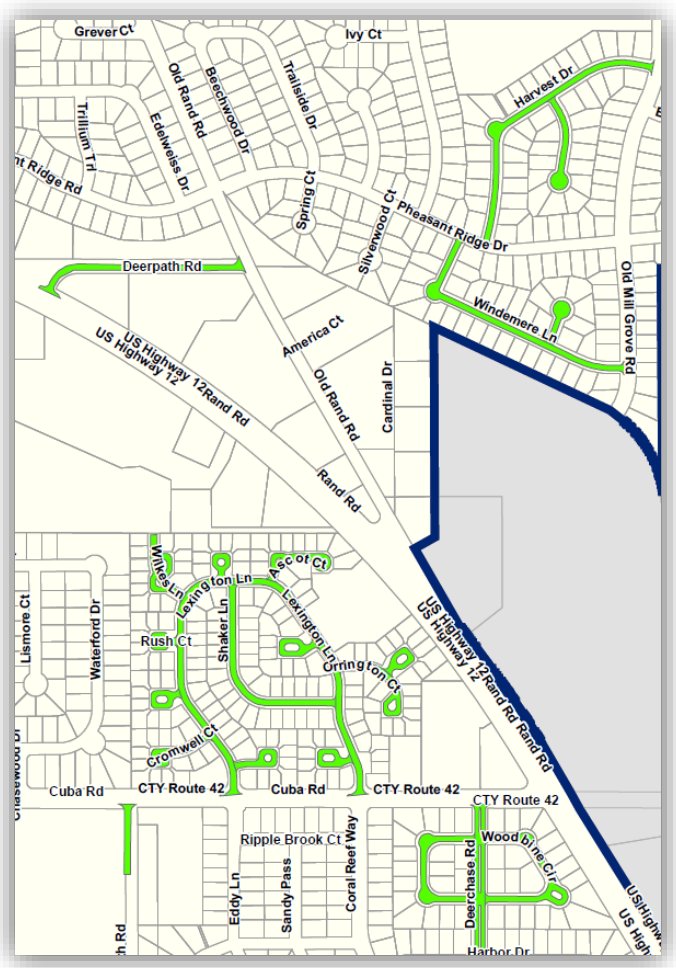


2017 Road Program: Sparrow Ridge and Various Locations

The 2019 Road Program will consist of the streets highlighted in **green** in *Figure 18*. The current average area-weighted PCI rating for the highlighted streets is 52 (Poor), however the projected PCI by the time of the project is approximately 39 (Very Poor).

The Sparrow Ridge subdivision will require mill and overlay with minimal patching. Other various streets surrounding Sparrow Ridge were chosen due to their close geographic location and poor condition. The portion of Deerpath Road south of Cuba Road has a current PCI of 9 (failed), and will require either deep mill and overlay with patching, or reconstruction. All streets will require further inspection in 2016 to determine exact patching quantities and resurfacing depth.

Figure 16 - 2017 Road Program



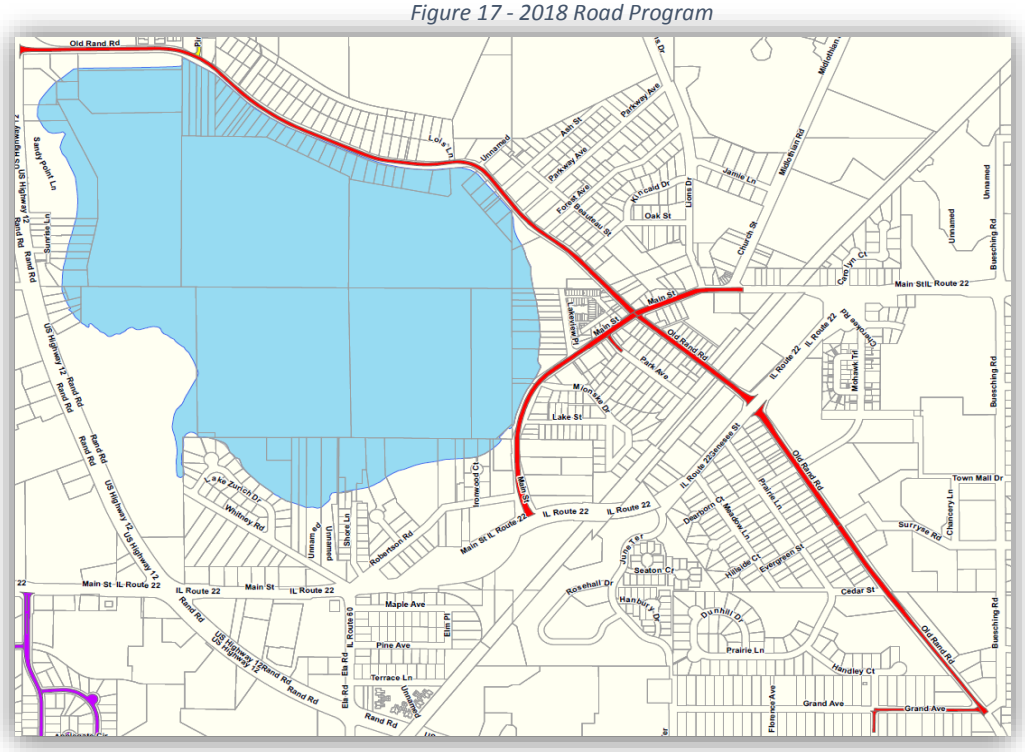
2018 Road Program: Old Rand Rd, Main St, Park Ave

The 2018 Road Program will consist of the streets highlighted in **red** in *Figure 17*. The average time since last major work for all streets in the proposed road program will be 21 years in 2018. The current average area-weighted PCI rating for the highlighted streets is 53 (Poor), however the projected PCI by the time of the project is approximately 43 (Poor).

Main Street and Old Rand Road are both high volume roadways and major thoroughfares for the Village of Lake Zurich. Main Street shows signs of base failure, but the issue is not widespread. Mill and overlay with patching on both Main Street and Old Rand Road will likely provide sufficient repair. Small sections of both Park Avenue and Edelweiss Drive are in disrepair, and have been added to the 2018 Road Program due to their proximity to the project and severity of distresses. Grand Avenue is also included in the road program due to its proximity to the project, and will require a thin mill and overlay.

Main Street is poised to undergo major commercial improvements in the coming years, and depending on Village instruction, 2018's proposed road program may be pushed back until large construction equipment will no longer be using the road on a regular basis. However, Main St is currently at a 41 PCI (Poor), which could be as low as a 31 PCI (Very Poor) by the projected road program date. The street life may be extended with the use of patching, however regardless of commercial development in the downtown area, Main St and Old Rand Rd should be rehabilitated within the next 4-7 years.

Figure 17 - 2018 Road Program

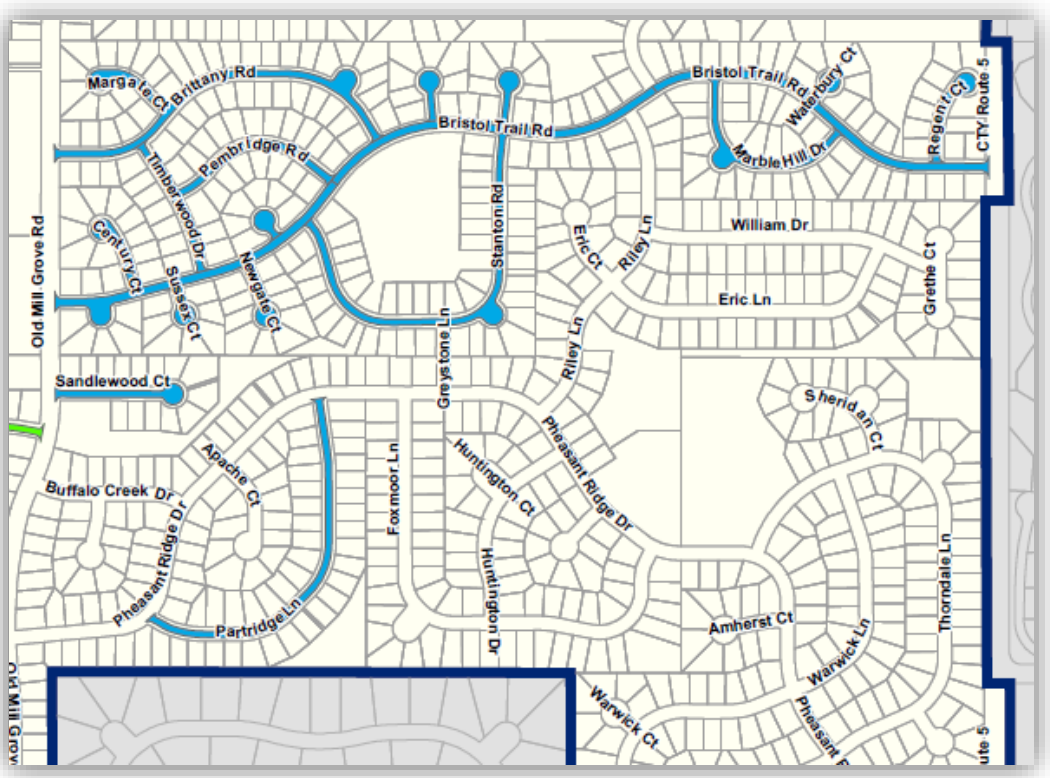


2019 Road Program: Bristol Trail

The 2017 Road Program will consist of the streets highlighted in **blue** in *Figure 16*. The average time since last major work for all streets in the proposed road program will be 15 years in 2017. The current average area-weighted PCI rating for the area is 62 (Satisfactory), however the projected PCI by the time of the project is approximately 54 (Poor).

The Bristol Trail subdivision has an "urban" cross-section with curb, storm sewer, and sidewalk. The project area shows signs of stress cracking in the tire lanes, possibly from heavy garbage trucks. It is possible to limit the cost of rehabilitation by performing a mill and surface treatment, and patching base failure in the tire lanes. Pavement cores should be taken in 2019 to determine the extent of base failure. Over the next 2 years this area will be monitored for further distress, and the rehabilitation techniques may be altered as necessary.

Figure 18 - 2019 Road Program



VII. Conclusion

The comprehensive pavement evaluation revealed that Lake Zurich's overall Roadway Network is in good condition (PCI – 73). The Village currently allocates the majority of its road program funds to major repair projects. One goal of this PMP is to promote a robust routine and preventative maintenance program – following the "keeping good roads good" philosophy. Preventative maintenance on "good" roads is a cost effective way to increase pavement life, and in turn reduce the frequency of major repairs.

The Plan includes helpful information on the types of pavement distresses commonly observed in Lake Zurich along with recommended maintenance and repair strategies. The PMP is meant to serve as a guideline for Village roadway maintenance policy. Further, the PMP is a living document that should be evaluated on a regular basis to ensure it is meeting the goals of the Village. Updating the PAVER™ database as new information becomes available will increase the accuracy of the deterioration curves and pavement condition forecasting tools.

Based on the findings of this study, Manhard Consulting offers the following recommendations:

- Adopt the PMP as framework for future maintenance of Village streets.
- Strive to set in place annual preventative maintenance and major repair budgets to maintain the current PCI long term.
- Refine budgets and work plans as new streets are added to the Village inventory (Coventry Creek, Donata Court, Lake Zurich Sunset, etc.).
- Account for construction price inflation when budgeting for future annual road programs.
- Coordinate Utilities Division upgrades and repairs in advance of projected road construction projects.
- Perform pavement coring and field inspection to develop the appropriate maintenance and repair strategies before proceeding to construction.
- Update the PAVER™ database regularly when streets are transferred to the Village or annual work is being performed.
- Perform Village-wide pavement condition re-inspections (every five years) in conjunction with the preparation of subsequent five-year capital plans.

Pavement Management Plan

Appendix 1

Manhard CONSULTING

Section 1:
PCI Road Condition Values

At the Heart of Community

PCI Values

- Failed (0 - 10)
- Serious (11 - 25)
- Very Poor (26 - 40)
- Poor (41 - 55)
- Satisfactory (56 - 70)
- Good (71 - 85)
- Excellent (86 - 100)

MATCH LINE

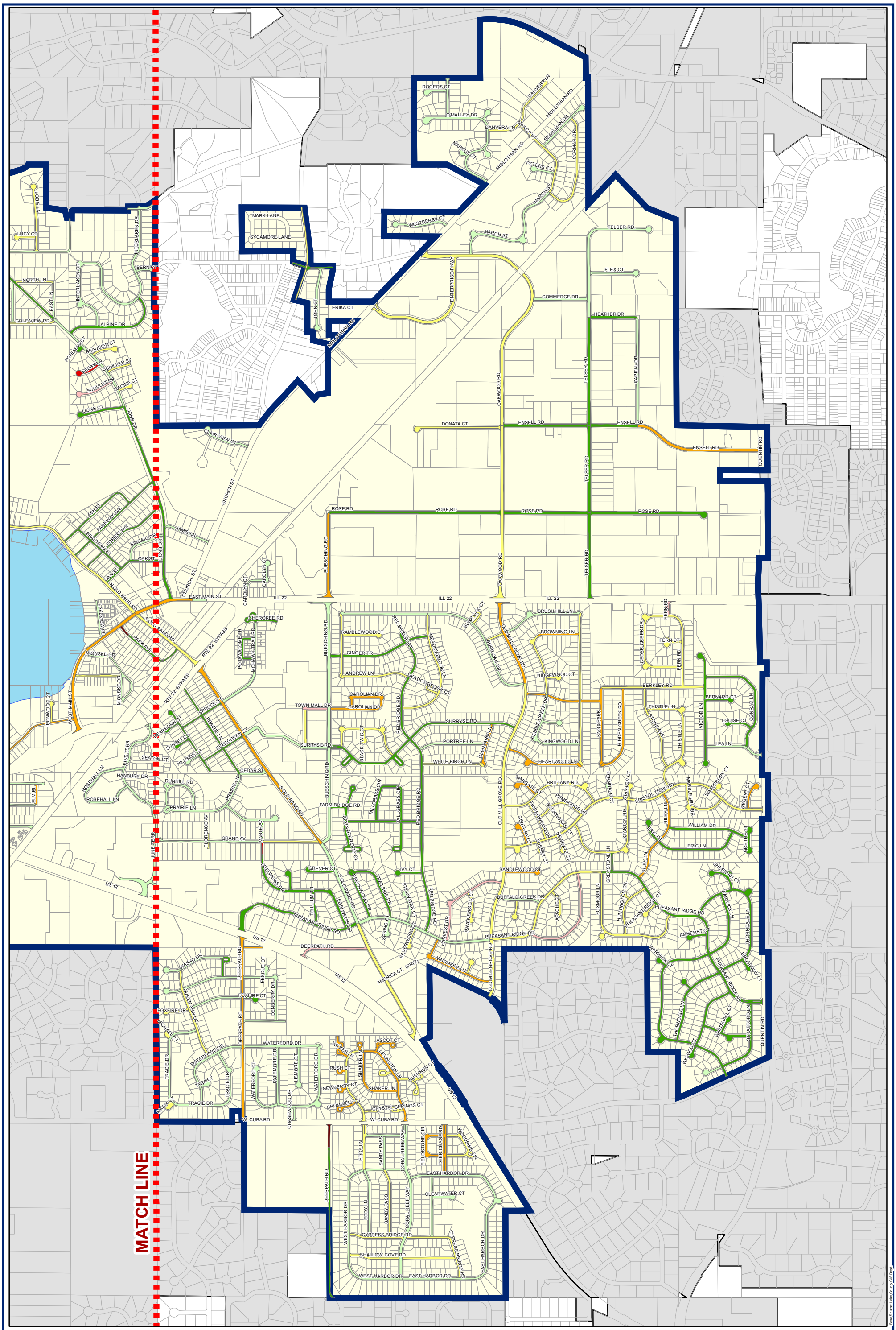
Manhard CONSULTING LTD

Date: 01/15/14 Scale: 1":1000'

0 500 1,000 Feet

N

Base Source: Lake County GIS Dept



Section 2:
PCI Road Condition Values

PCI Values

- Failed (0 - 10)
- Serious (11 - 25)
- Very Poor (26 - 40)
- Poor (41 - 55)
- Satisfactory (56 - 70)
- Good (71 - 85)
- Excellent (86 - 100)

Village of Lake Zurich — At the Heart of Community

Manhard Consulting Ltd

Date: 01/14/15 Scale: 1":1300'

0 650 1,300 Feet

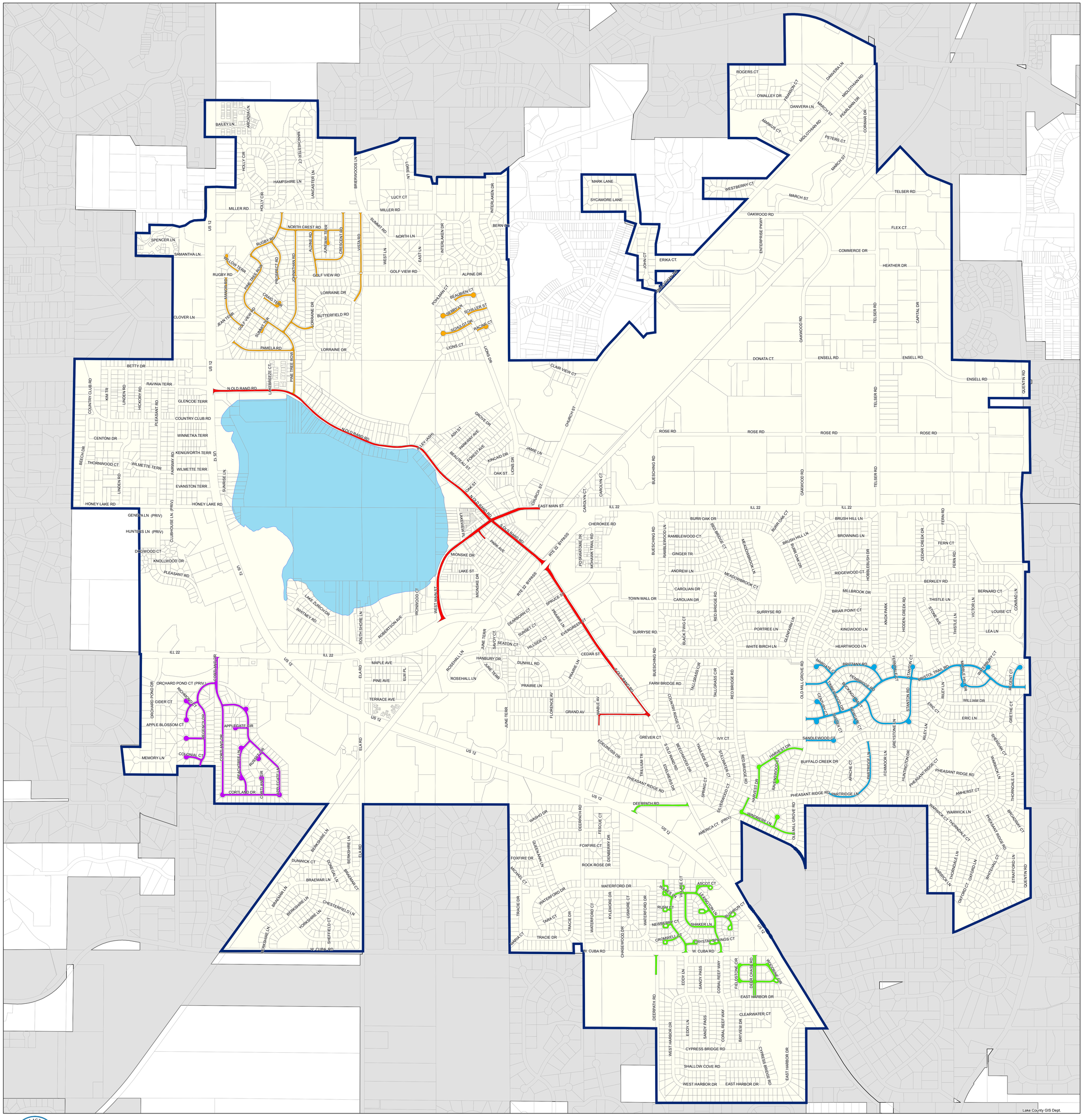
N

Base Source: Lake County GIS Dept.

Pavement Management Plan

Appendix 2

Manhard CONSULTING



Five Year Program Plan Map ($2 Million Annual)

VILLAGE OF LAKE ZURICH
At the Heart of Community

Program Project Year

- 2015
- 2016
- 2017
- 2018
- 2019

DRAFT Date: 01/19/15
Scale: 1":1000'

0 500 1,000 Feet

N

Manhard CONSULTING LTD